

Northern Continental Divide Ecosystem Grizzly Bear Population Monitoring Team Annual Report – 2022

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ABSTRACT

This report summarizes 2022 results of the interagency population monitoring program for grizzly bears in the Northern Continental Divide Ecosystem (NCDE) of Montana, initiated in 2004. The program is focused on modeling population trend using survival and reproductive rates obtained from captured and radio-marked bears, particularly females. The program also maintains all grizzly bear data; conducts research to meet management needs; summarizes agency actions to prevent and respond to human-grizzly bear conflict; and evaluates demographic objectives outlined in the NCDE Conservation Strategy. During 2022, we captured 24 grizzly bears (17F, 7M) for trend monitoring within the Demographic Monitoring Area (DMA) and 57 bears (24F, 33M) for management or other purposes inside and outside of the DMA. Including bears captured in previous years, we radio-monitored 34 bears (27F, 7M) for trend and documented 0 deaths. For other purposes, we radio-monitored 51 bears (34F, 17M) and documented 9 deaths (3F, 6M). We recorded reproductive status of 46 females ≥ 4 years old and documented 3 presumed mortalities among 4 cub litters (10 total) and 2 presumed mortalities among 2 yearling litters (4 total). Including unmarked bears, we documented 51 known or probable mortalities of grizzly bears in or near the NCDE. We evaluated demographic objectives set forth in the 2019 Conservation Strategy. During the 6-year period of 2017–2022, all 23 Bear Management Units (BMUs) and 7 Occupancy Units (OUs) were occupied by females with offspring, above the minimum thresholds of 21 BMUs and 6 OUs. During 2017–2022, we estimated an annual survival rate of 0.93 (± 0.01 SE) for independent females, above the minimum threshold rate of 0.92. Within the DMA, we estimated 24 total reported and unreported (TRU) mortalities for independent females and 27 TRU mortalities for independent males. During 2017–2022, average TRU mortalities were 15 and 25, below the maximum thresholds of 25 and 30, for independent females and males respectively. Using revised parameters, we estimated that the occupied range of the NCDE population during 2008–2022 was 55,652 km² and increased approximately 11% since 2020. To date, no movements have been detected between the NCDE and the Greater Yellowstone Ecosystem, and no interbreeding of bears from different ecosystems has been observed. Management specialists in the NCDE responded to at least 285 incidents of human-grizzly bear conflict and another 122 other reports or complaints not involving conflict behavior. They applied 582 tools or actions to prevent conflict and took another 71 actions involving captured bears.

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INTRODUCTION

The grizzly bear (*Ursus arctos horribilis*) was listed as threatened under the Endangered Species Act in the lower 48 states in 1975. The grizzly bear population in the Northern Continental Divide Ecosystem (NCDE) was considered to be the largest among the existing listed populations and was contiguous with populations in Canada. Various regional studies of ecology and population dynamics were conducted within this ecosystem during the 1970s through 1990s (e.g., Martinka, 1976, Servheen 1983, Zager et al. 1983, Mace and Jonkel 1986, Aune et al. 1994, Mace and Waller 1997). Attempts to estimate overall population size from counts of females with cubs, as described in the Recovery Plan (USFWS 1993), were compromised by the dense forest cover in many parts of the ecosystem and experimental photographic sighting methods for estimating population size (Mace et al. 1994) were not applied ecosystem wide. In 2004, our interagency team was formed to provide ecosystem-wide information on population size and trend (Mace 2005). An ecosystem-wide genetic mark-recapture study, led by the US Geological Survey (USGS), estimated the population size at 765 bears in 2004 (Kendal et al. 2009). Ongoing field studies, led by Montana Fish, Wildlife & Parks (FWP), allowed us to model population trend using survival and reproductive rates obtained from captured and radio-marked bears, particularly females (Mace et al. 2012, Costello et al. 2016). In 2019, these methods were used to develop a set of population objectives for the NCDE Conservation Strategy (NCDE Subcommittee 2019). Although the Conservation Strategy was intended to take effect upon removal of the NCDE grizzly bear population from threatened status under the Endangered Species Act, the objectives and thresholds represented the most recent monitoring methodologies. The Conservation Strategy also called for annual reporting of incidents of human-grizzly bear conflict and agency response.

Our trend monitoring program was focused within the Demographic Monitoring Area (DMA; Fig. 1), which encompasses the Primary Conservation Area (PCA: equivalent to the Federal Recovery Zone) and Zone 1, a buffer surrounding the PCA (USFWS 1993, NCDE Subcommittee 2019). The DMA includes Glacier National Park, parts of 4 National Forests (Flathead, Helena/Lewis and Clark, Kootenai, and Lolo); parts of the Blackfoot and Flathead Reservations; Bureau of Land Management lands; state lands, and private lands. The NCDE grizzly bear population was also contiguous with those in the Canadian provinces of British Columbia and Alberta, therefore occasional captures and monitoring occurred north of the United States in Canada. For reporting field results within the DMA, we designated 9 DMA subunits (see Appendix A) based on watersheds, distinct land ownerships, and grizzly bear population management authorities.

Although our focus for trend monitoring was the DMA, we also worked in areas where grizzly bears were present outside of the DMA. Notable areas included: Zone 2, an area of potential connectivity between the NCDE and the Greater Yellowstone Ecosystem (GYE); and Zone 3, an area occupied by grizzly bears which does not provide habitat linkage to other grizzly bear populations (NCDE Subcommittee 2019).

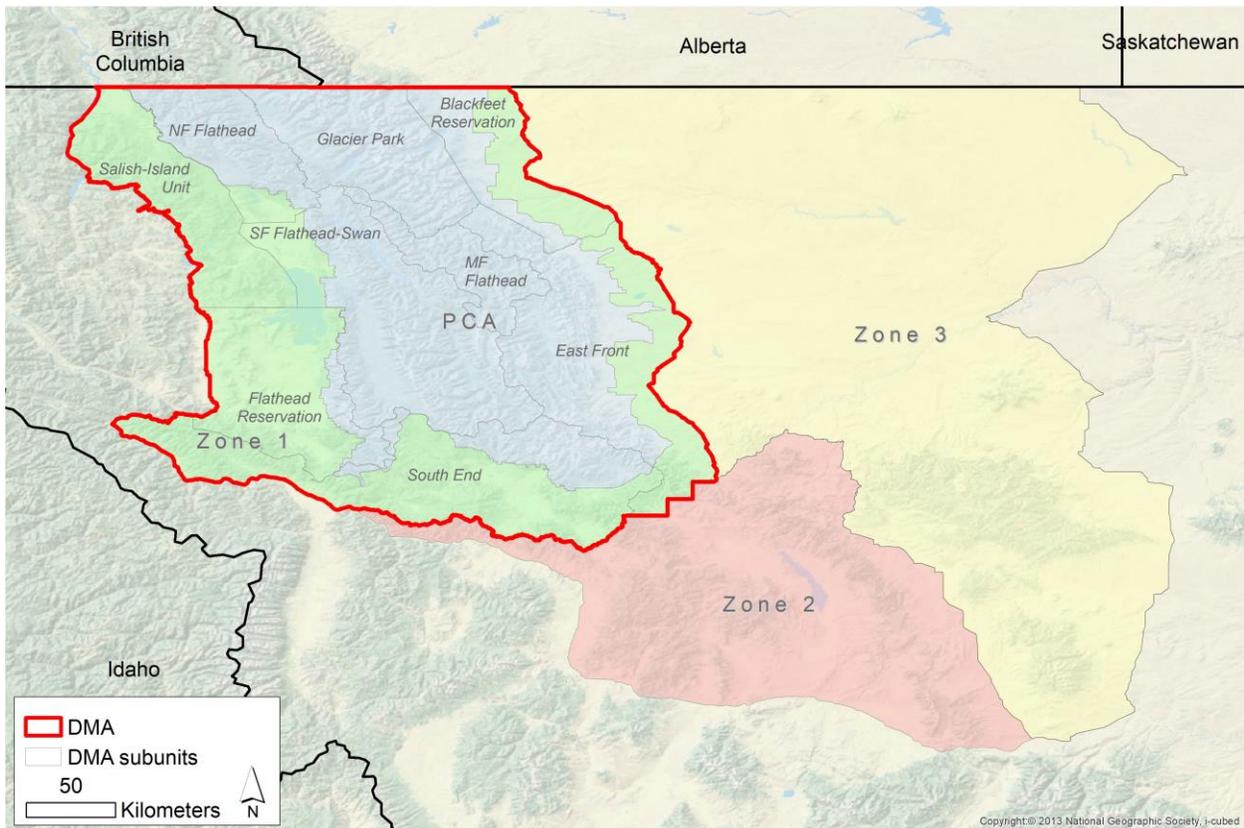


Figure 1. Zones of the NCDE. The Demographic Monitoring Area (DMA; red line), where population monitoring is conducted, consists of the Primary Conservation Area (PCA; blue) and Zone 1 (green). DMA subunits (gray lines) are used for localized population analyses. Zone 2 (pink) is the area of potential genetic connectivity between the NCDE and the Greater Yellowstone Ecosystem. Zone 3 (orange) is an area occupied by grizzly bears which is not likely to provide habitat linkage to other populations.

SUMMARY OF ANNUAL TREND MONITORING FIELD ACTIVITIES

Methods

We captured grizzly bears using leg-hold snares and culvert traps. We followed the handling and immobilization procedures found in the Montana Animal Care and Use Committee protocols for grizzly bears and black bears (Montana Fish, Wildlife and Parks 2004). We tagged all bears subcutaneously with passive transponder tags and pulled a premolar tooth for age determination when possible (Stoneberg

and Jonkel 1966). For trend monitoring, we radio-marked most females and a sample of males with radio-transmitters. Currently deployed transmitters included: Iridium neck-mounted GPS collars (TGW-4570-3; Telonics, Inc.); very high frequency (VHF) collars (Telonics, Inc., Mesa, AZ); and VHF ear-tag transmitters (Advanced Telemetry Systems, Inc., Isanti, MN). We captured trend bears throughout the DMA. We attempted to distribute our sample of trend females roughly in proportion to relative grizzly bear density, based on the distribution of female bears detected at DNA hair traps in 2004 (Kendall et al. 2009, Kendall et al. 2019). Grizzly bears were also captured and radio-marked for management and other research outside of the DMA. Individual bears were classified as either trend bears or other (non-trend) bears using the terminology of Mace et al. (2012).

We monitored survival and reproduction using aerial telemetry flights conducted during the active season and remote downloads of GPS data. We attempted to investigate mortality signals within 2 weeks to ascertain whether the bear died or shed its collar. If a dead bear was found, we conducted preliminary necropsies in the field and collected relevant samples for laboratory analyses. In early spring, when bears were beginning to emerge from dens, we conducted observation flights for adult female bears to ascertain reproductive status, age of offspring, and litter size (if present). We continued to conduct telemetry flights throughout the active season, when possible, to document survival of dependent offspring.

We recorded known and probable mortalities of marked and unmarked grizzly bears inside and outside of the DMA. Known mortalities involved a whole or partial carcass which substantiated death; probable mortalities lacked a carcass but involved strong evidence that a bear had died (e.g., blood loss).

During field activities, we opportunistically collected hair samples left by bears under various circumstances, such as bears that visited trap sites, bears that rubbed on natural and man-made objects, or bears that were present at sites of human-grizzly bear conflict. If the samples appeared adequate, we included them in DNA analyses for individual identification. These samples contributed to our sample of genotypes for analyses of population genetics and provided additional information about captured individuals, such as conflict history or continued presence in the population.

Results

In 2022, we captured 81 individuals during 91 capture occasions (10 recaptures; Fig. 2). We captured 25 individuals for trend monitoring purposes within the DMA (Table 1), including 17 females and 8 males. Fifteen females and 3 males were fitted with radio-transmitters. In addition to trend captures, 52 bears were captured in association with management actions, although some were non-target individuals or were captured preemptively. These captures included 22 females and 30 males. Of these,

13 females and 11 males were fitted with radio-transmitters. Two females and 2 males were captured and radio-marked for research outside of the DMA.

Table 1. Number of individual grizzly bears captured and fitted with radio-transmitters in the NCDE, 2022.

Type ¹	Captured			Radio-marked		
	Female	Male	Total	Female	Male	Total
Trend research in DMA	17	8	25	15	3	18
Management ²	22	30	52	13	11	24
Research outside of DMA	4	2	4	2	2	4
Total	41	40	81	30	16	46

¹ Bears with multiple captures within the year were placed in only one category: research if it occurred anytime, otherwise first capture type. ² Management captures included bears captured for conflict, non-target bears captured at conflict sites, bears captured preemptively to prevent conflict, and bears captured in other circumstances.

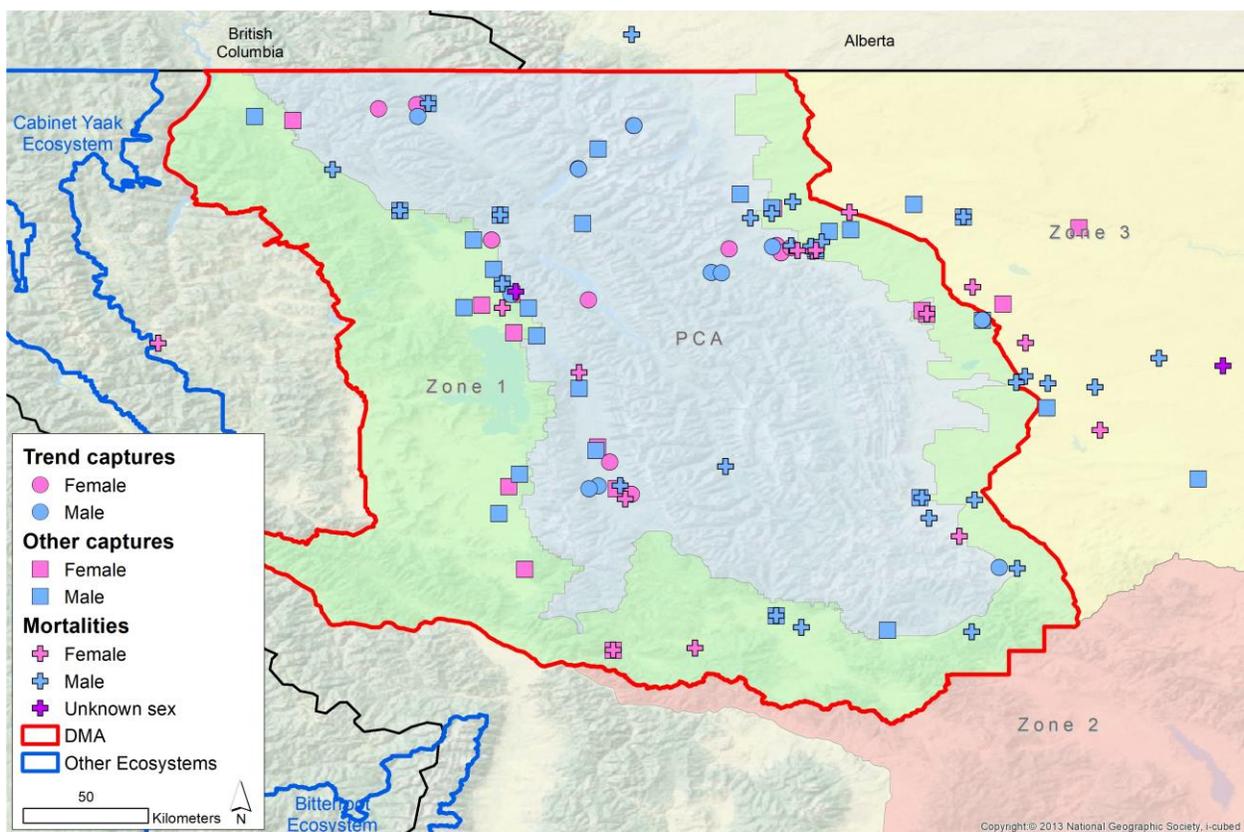


Figure 2. Location of captures and mortalities of grizzly bears in the NCDE, 2021. Zones as described in Fig. 1.

Including bears collared during previous years, we radio-monitored 34 independent bears during all or part of 2022 for trend monitoring within the DMA: 27 females and 8 males. We did not document any deaths within this trend sample. For management or other purposes, we monitored 51 bears: 32 independent females, 2 dependent females, 15 independent males, and 1 dependent male. Among this

other sample, we documented the deaths of 9 radio-marked bears: agency removal due to human-bear conflict (1F:4M); agency removal due to injury (1F); legal harvest in AB, Canada (1F); defense of life (1M); and undetermined (1M). A summary of the fates of radio-marked bears during 2022 are presented in Appendix A.

We recorded the reproductive status of 46 females ≥ 4 years old during 2022, including 41 radio-monitored females and 5 other identified bears. Among all observations, there were 15 females with cubs (32%), 4 with yearlings (9%), 3 with 2-year-old offspring (7%), and 24 with no offspring (52%). Cub litter sizes range from 1 to 3, with a mean of 2.0. However, dates of first observations for reproductive status ranged from 7 April to 7 October and averaged 8 July, therefore some individuals may have changed status due to whole litter loss or independence of offspring. Among 12 females first observed in April or May (soon after den emergence), we observed 3 females with cubs (25%), 2 with yearlings (16%), 3 with 2-year-olds (25%), and 4 with no offspring (33%). Litter size was 3 cubs for all cub litters observed during these months. We monitored survival of 4 cub litters (10 cubs) and 2 yearling litters (4 yearlings) through repeated observations during different months of the year. We documented 3 presumed cub mortalities and 2 presumed yearling mortalities. A summary of the reproductive observations of females are presented in Appendix B.

Fifty-one known or probable grizzly bear mortalities were documented in or near the NCDE during 2022 (Fig. 2; Table 2). Thirty-nine occurred within the DMA: 17 inside the PCA and 22 within Zone 1. Nine mortalities occurred outside the DMA in Zone 3. Three mortalities occurred outside the NCDE zones recognized in the Conservation Strategy: 1 in the Cabinet-Yaak Recovery Zone and 2 in Alberta, Canada. These were recorded because the bears had previously been captured in the NCDE. Among 38 mortalities of independent bears, causes of death were: agency removal due to human-bear conflict (20); automobile collision (7); train collision (2); management removal due to injury (2); legal harvest in Canada (2); defense of life (1); illegal defense of property (1); accidental poisoning (1); and unknown or under investigation (2). Thirteen dependent bear mortalities included individuals that died, individuals that were orphaned and then captured and moved to zoos, or cubs that were orphaned and assumed dead (if fate is unknown, cubs were assumed dead). Causes of death were: agency removal due to conflict (4); agency removal due to disease (3); automobile collision (2); train collision (1); orphaning (1); and natural (2). All 3 dependent-aged bears removed for disease tested positive for highly pathogenic avian influenza (HPAI), representing the first known cases of this disease in grizzly bears (FWP, press release, 2022). The first cases of HPAI in black bears were also observed in 2022 in Alaska (Alaska Department of Fish and Game, press release, 2022). A summary of all documented mortalities in the NCDE during 2022 is reported in Appendix C.

Table 2. Number of known or probable mortalities of grizzly bears in the NCDE, 2022.

	Ageclass	Sex			Total
		Female	Male	Unknown	
Inside DMA	Dependent	3	7	0	10
	Independent	12	16	1	29
	Total	15	23	1	39
Outside DMA	Dependent	1	1	1	3
	Independent	4	5	0	9
	Total	5	6	1	12

During 2021, we collected 123 opportunistic samples. Among them, 54 (44%) were successfully genotyped as grizzly bears (Fig. 3). Other samples were found to be from black bears or were not successfully genotyped due to scarcity of hair follicles, mixture of individuals within the sample, or failure of DNA extraction or genotyping. A total of 36 individuals were detected among these samples (Table 3). Number of total detections per individual ranged from 1–7 with an average of 1.5. Fifty percent of individuals had not been previously captured and were identified as new individuals.

Table 3. Annual numbers of grizzly bears genotyped from opportunistic DNA samples collected in the NCDE, 2012–2021, and percent newly versus previously identified.

Individuals	Year									
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Total genotyped	23	23	18	15	33	29	27	35	34	36
Newly identified	43%	35%	28%	40%	48%	41%	52%	43%	35%	50%
Previously identified	57%	65%	72%	60%	52%	59%	48%	57%	65%	50%

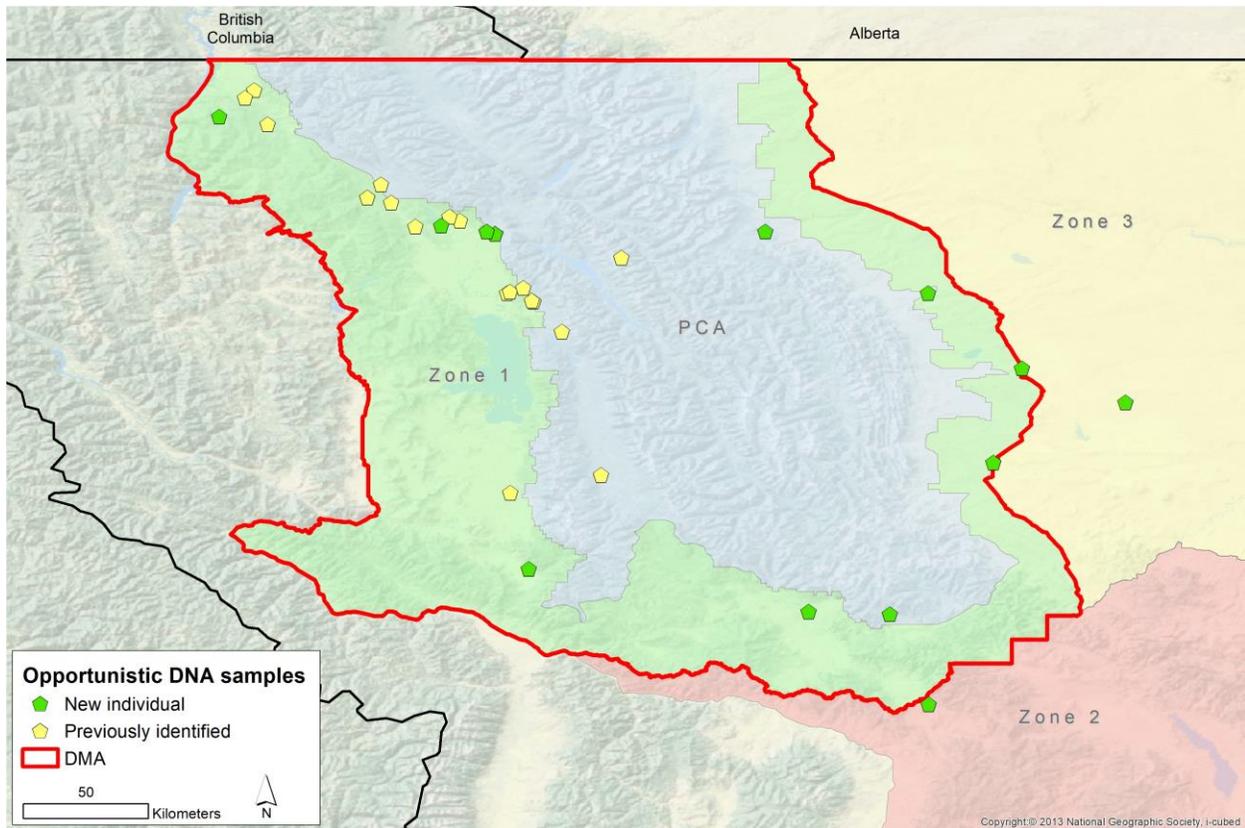


Figure 3. Locations of opportunistic samples from grizzly bears successfully genotyped in the NCDE, 2021. Zones as described in Fig. 1.

EVALUATION OF CONSERVATION STRATEGY OBJECTIVES AND THRESHOLDS

The NCDE Conservation Strategy (NCDE Subcommittee 2019) articulated an overarching management goal to maintain a recovered, genetically diverse grizzly bear population throughout the DMA while maintaining demographic and genetic connections with Canadian populations and providing the opportunity for demographic and/or genetic connectivity with other ecosystems, with the following objectives and thresholds:

Objective 1: Maintain a well-distributed grizzly bear population within the DMA

- **Occupancy threshold:** Maintain the documented presence of females with offspring in at least 21 of 23 BMUs of the PCA and in at least 6 of 7 occupancy units of Zone 1 at least every 6 years.

Objective 2: Manage mortalities from all sources to support a $\geq 90\%$ estimated probability that the grizzly bear population within the DMA remains above 800 bears, considering the uncertainty associated with all the demographic parameters.

- Independent female survival threshold: Using a 6-year running average, maintain estimated annual survival of independent females within the DMA to: (a) a rate of ≥ 0.90 ; and (b) a rate at or above the minimum level consistent with a projected $\geq 90\%$ probability that the population within the DMA will remain above 800 bears based on population modeling.
- Independent female mortality threshold: Using a 6-year running average, limit annual estimated number of total reported and unreported (TRU) mortalities of independent females within the DMA to: (a) a number that is $\leq 10\%$ of the number of independent females estimated within the DMA based on population modeling; and (b) a number that is at or below the maximum level consistent with a projected $\geq 90\%$ probability that the population within the DMA will remain above 800 bears based on population modeling.
- Independent male mortality threshold: Using a 6-year running average, limit annual estimated number of TRU mortalities of independent males within the DMA to a number that is $\leq 15\%$ of the number of independent males estimated within the DMA based on population modeling.

Objective 3: Monitor demographic and genetic connectivity among populations

- Estimate spatial distribution of the NCDE grizzly bear population biennially.
- Identify the population of origin for individuals sampled inside and outside of the DMA to detect movements of individuals to and from other populations or recovery areas.

Methods

We documented presence of females with cub, yearling, or 2-year-old offspring within units, based on visual observations obtained from radio-marked females; verified remote camera photos; other verified visual observations; known or probable mortalities of family units (death of the mother, dependent young, or both); and telemetry or GPS locations of radio-marked females known to have offspring. For Objective 1, the PCA component represented a continuation of the occupancy targets established within the Recovery Zone prior to delisting (USFWS 1993) and utilized the same BMUs (Fig. 4). The Zone 1 component utilized Occupancy Units (OUs) demarcated using established political boundaries (i.e., state/tribal boundaries and FWP regional boundaries) and the boundaries of the 2 Demographic Connectivity Areas (NCDE Subcommittee 2019).

We estimated survival of independent females within the DMA based on known-fate analysis of data collected from radio-marked female bears within the DMA (Costello et al. 2016). Analysis incorporated the time series of survival data from known-fate monitoring since 2004 and differentiated

the most recent 6 years of data to compare to the threshold. We estimated numbers of TRU mortalities of independent female and male grizzly bears within the DMA and assessed thresholds using an average for the last 6 years. For each sex, the number of TRU mortalities was the sum of: the count of agency-sanctioned management removals; the count of known or probable deaths of bears wearing functional radio-transmitters (excluding those that were agency removals); and an estimate of the numbers of other mortalities that were or were not reported or discovered. To obtain these estimates, we summed mortalities of non-radioed bears reported by the public or discovered by agency personnel for each sex. If sex was unknown, it was randomly assigned. Because these counts represent some unknown fraction of the true number, we applied reporting/discovery rates observed among deaths of radio-marked bears to inflate this count to an estimate of the numbers of reported plus unreported mortalities of non-radioed bears (Cherry et al. 2022, Costello et al. 2016).

Thresholds for Objective 2 were previously developed for a 6-year management period of 2019–2023 (NCDE Subcommittee 2019). For this period, the NCDE grizzly bear population was projected to increase from approximately 1,068 bears in 2019 to 1,163 bears in 2023 (Table 4), assuming previously observed vital rates which are consistent with an annual growth rate of 2.3% per year (Costello et al. 2016). To establish thresholds, we simulated population growth using observed vital rates (Costello et al. 2016) to year 2012, and then projected another 25 years using multiple levels of independent female survival (i.e., 0.90, 0.91, 0.92, 0.93, and 0.94), while holding independent male survival at 0.85. By constraining the models to maximum allowable mortality for males, the resulting female thresholds would be the most conservative values associated with meeting Objective 2. Under simulations for the 6-year management period of 2019–2023, the minimum threshold for independent female survival in 2021 was 0.93, the maximum threshold for the number of independent female mortalities in 2021 was 24, and the maximum threshold for the number of independent male mortalities in 2021 was 29 (NCDE Subcommittee 2019).

Table 4. Projected annual population size of grizzly bears in the NCDE for the management period 2019–2023 assuming previously observed vital rates (Costello et al. 2016).

Estimate	Year				
	2019	2020	2021	2022	2023
Population size	1,068	1,092	1,114	1,138	1,163
95th percentile	906–1,243	923–1,276	938–1,305	958–1,335	971–1,366

Beginning in 2022, we estimated the spatial distribution, i.e. occupied range, of the NCDE grizzly bear population by applying zonal analysis and ordinary kriging to 3 x 3-km cells with verified grizzly bear locations documented during a 15-year window up to the current year (Bjornlie et al. 2014). Although the method is the same, the parameters differ slightly from those described in the Conservation Strategy (NCDE Subcommittee 2019) and used during previous years, whereby we applied zonal analysis and ordinary kriging to 7 x 7-km cells during a 10-year window up to the current year. The rationale for making this change was an inter-agency decision to use consistent methods for estimating occupied range in all of the grizzly bear ecosystems in the lower 48 states. We adopted the parameters developed and used in the GYE and developed guidance on how to treat locations obtained from translocated or relocated bears (see Appendix F). As previously, verified locations used to determine occupancy of cells were collected from GPS transmitters; VHF telemetry flights; capture and mortality locations; human-grizzly bear conflict sites; verified observations (sightings or tracks) or remote camera photos confirmed by agency personnel; and opportunistic samples of grizzly bear hair, blood, scat, or tissue confirmed by DNA analysis. Unlike previously, we screened GPS data to exclude all but one randomly selected location per bear per day. This ensured that GPS data were not overrepresented in the data set and were appropriately scaled to the daily activity radius used to determine grid size. We defined occupied range as an estimate of the roughly contiguous area within which bears have established residency or have demonstrated habitat use. Our interagency group agreed that it should not include very low-density peripheral areas or areas used for only occasional forays, therefore, occupied range does not represent the total known extent of occurrence of grizzly bears.

Cooperating with other agencies, we continued to collect data on verified outlier locations outside of occupied range, which was used to delineate total known extent of grizzly bear occurrence, known as the “may be present” map. For this analysis, 12-digit hydrologic unit-code watersheds were mapped to indicate presence of grizzly bear observations during a 10-year window (US Fish and Wildlife Service 2020).

DNA samples obtained during captures or at any of verified grizzly bear sites were analyzed for population of origin to document movement of individuals to and from other populations or recovery areas (Haroldson et al. 2010). Genetic samples are not submitted until the end of each field season and take some time to analyze, therefore there is typically a 1-year lag in reporting results for population of origin.

Results

During 2022, we verified presence of reproductive females within 17 of 23 BMUs (73%) and within 6 of 7 OUs (86%; Fig. 4). For the 6-year period 2017–2022, all 23 BMUS were occupied by females with

offspring, thus exceeding the objective of 21 of 23 BMUs occupied (Appendix D). All 7 OUs were occupied during the last 6 years, exceeding the objective of 6 of 7 OUs occupied. Using the 6-year occupancy thresholds for the PCA and Zone 1 have been met each year since 2006. Previously, we reported no occupancy of the Birch Teton BMU by reproductive females in 2021 (Costello and Roberts 2022), but we have now verified occupancy during 2021 through remote cameras images taken in 2021, but not downloaded until 2022. This change is shown in Appendix D.

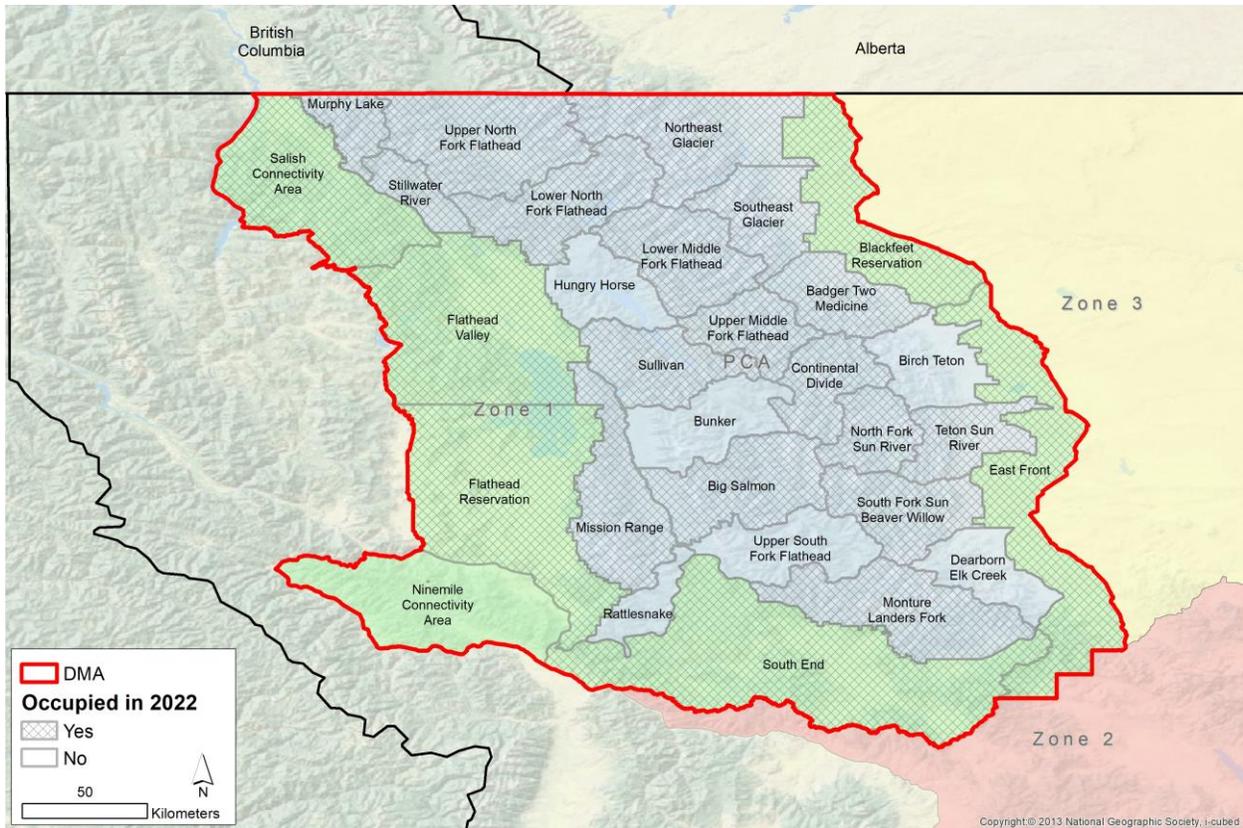


Figure 4. Documented occupancy of female grizzly bears with offspring within 23 BMUs of the PCA and 7 OUs of Zone 1, 2022. Occupancy was documented in all units during the last 6 years. Zones as described in Fig. 1.

For the 6-year period 2017–2022, we estimated an annual survival rate of 0.93 (\pm 0.01 SE) for independent females within the DMA, which exceeds the minimum threshold rate of 0.92 (NCDE Subcommittee 2019).

Within the DMA, there were 12 and 17 known mortalities reported for independent females and independent males during 2022, respectively (see Table 2). One independent aged unknown sex bear was randomly assigned as a male. We estimated the number of total reported and unreported (TRU) mortalities of independent bears within the DMA using these numbers and the reporting rates observed

among radio-marked bears. We estimated 13 TRU mortalities of independent females and 19 TRU mortalities of independent males within the DMA (Table 5). During 2017–2022, the average annual number of TRU mortalities for independent females within the DMA was 15, which falls below the maximum threshold of 25 (NCDE Subcommittee 2019). The average annual number for independent males was 25, falling below the maximum threshold of 30 (NCDE Subcommittee 2019). A summary of all demographic objectives for 2017–2022 are reported in Appendix E.

Table 5. Summary of independent grizzly bear mortalities within the DMA, NCDE, 2022.

Sex	Documented mortalities by method of discovery				Estimated reported and unreported ^e (C)	Estimated total mortality (A + B + C)
	Agency removal ^a (A)	Telemetry ^b (B)	Reported ^c (high)	Reported ^d (low)		
Female	8	1	3	0	4	13
Male	10	2	5	0	7	19
Total	18	3	8	0	11	32

^a Count of agency removals, including those involving radio-marked bears. ^b Count of deaths for bears wearing functional radio-transmitters, except for agency removals. ^c Count of non-radioed bear deaths reported by the public or discovered by agency personnel with high reporting rates (illegal defense-of-property, defense-of-life, train collision, automobile collisions, illegal hunting-misidentification). ^d Count of non-radioed bear deaths reported by the public or discovered by agency personnel with low reporting rates (poaching/malicious, natural, undetermined). ^e Bayesian estimate of the total number of reported and unreported deaths of non-radioed bears (Cherry et al. 2002 and Costello et al. 2016).

Using the revised parameters, the estimated occupied range of the NCDE grizzly bear population during 2008–2022 was 55,652 km² (Fig. 5). This current estimate encompassed 100% of the PCA, 84% of Zone 1, 15% of Zone 2, and 21% of Zone 3. Nearly 3,000 km² of occupied range occurred outside of the NCDE Conservation Strategy Zones between the NCDE, CYE, and BE. We also estimated occupied range during 2006–2020 (and earlier windows) using the revised parameters, to allow us to evaluate range expansion and to illustrate the influence of the parameters on the resulting estimate. The revised 2020 estimate was 50,040 km², indicating that occupied range increased by about 11% between 2020 and 2022 (Fig. 5). Observed range expansion was most significant in the southwest, where occupancy was observed south of Interstate-90, and in the northeast, where range expanded eastward within the Blackfeet Reservation. During 2021 and 2022, outlier observations were confirmed in the Anaconda, Bitterroot, Boulder, Elkhorn, Garnet, Moccasin, and Sapphire mountains, as well as in the Sweetgrass Hills and the Missouri and Judith river basins. Based on revised biennial estimates beginning in 2004 (Appendix G), occupied range of the NCDE grizzly bear population increased an average of 3% per year from 2004–2022. The estimated percentage increase was also 3% per year during 2004–2020 using the unrevised method.

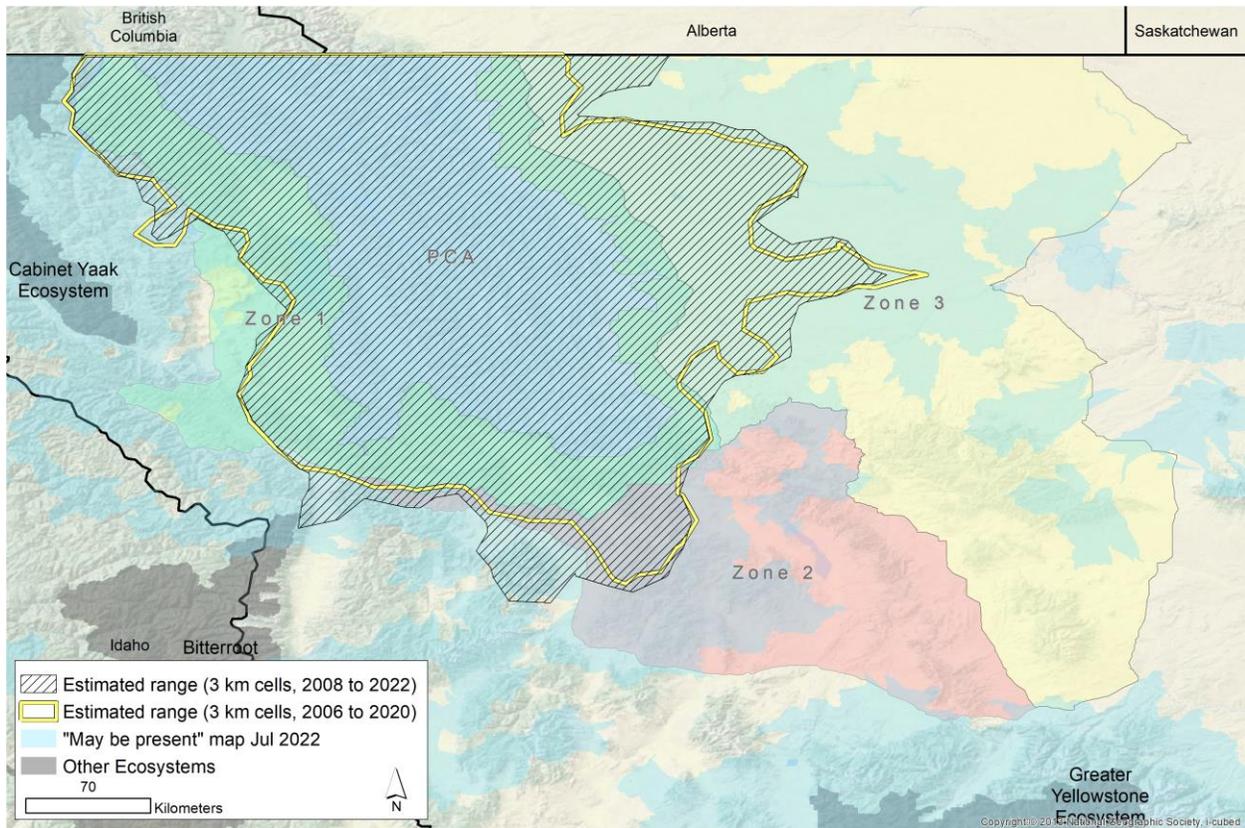


Figure 5. Occupied range of the NCDE grizzly bear population during 2008–2022 (and during 2006–2020 for comparison), as estimated by applying zonal analysis and ordinary kriging to 3x3-km cells with verified grizzly bear locations during the 15-year window. The “may be present” map shows the known extent of occurrence within watersheds, including those where outlier observations were verified. Zones as described in Fig. 1.

The revised method resulted in a more compact and realistic estimate of occupied range than the unrevised method for 2020 (Fig. 6). This was primarily due to the revised cell size (3 x 3-km versus 7 x 7-km), although there were some differences in occupied cells due to the revised window length (10 versus 15 years) and use of GPS data (all versus 1 per day). When cell size was larger, cells containing scattered locations near the periphery were more likely to be connected as nearest neighbors, and thus included within the kriged surface. For example, the scattered locations in the southern Boulder Mountains (near the intersection of Interstate Highway 90 and Interstate Highway 15) were included in the unrevised 2020 range but excluded in the revised 2020 range. Additionally, kriging based on the larger cell size tended to inflate and smooth the contour more than kriging based on the smaller cell size. For example, the unrevised 2020 range (and other unrevised ranges dating back to 2004) extended well south of Interstate Highway 90, even though only scattered locations were observed there. In contrast, the revised 2020 estimate (and other revised estimates back to 2004; Appendix G) remained north of Interstate Highway 90. Only the revised 2022 estimate extended south of Interstate-90 (Figure 2), when GPS locations and

multiple observations of unmarked bears demonstrated occupancy and sustained use of the Bitterroot and Flint Creek mountain ranges.

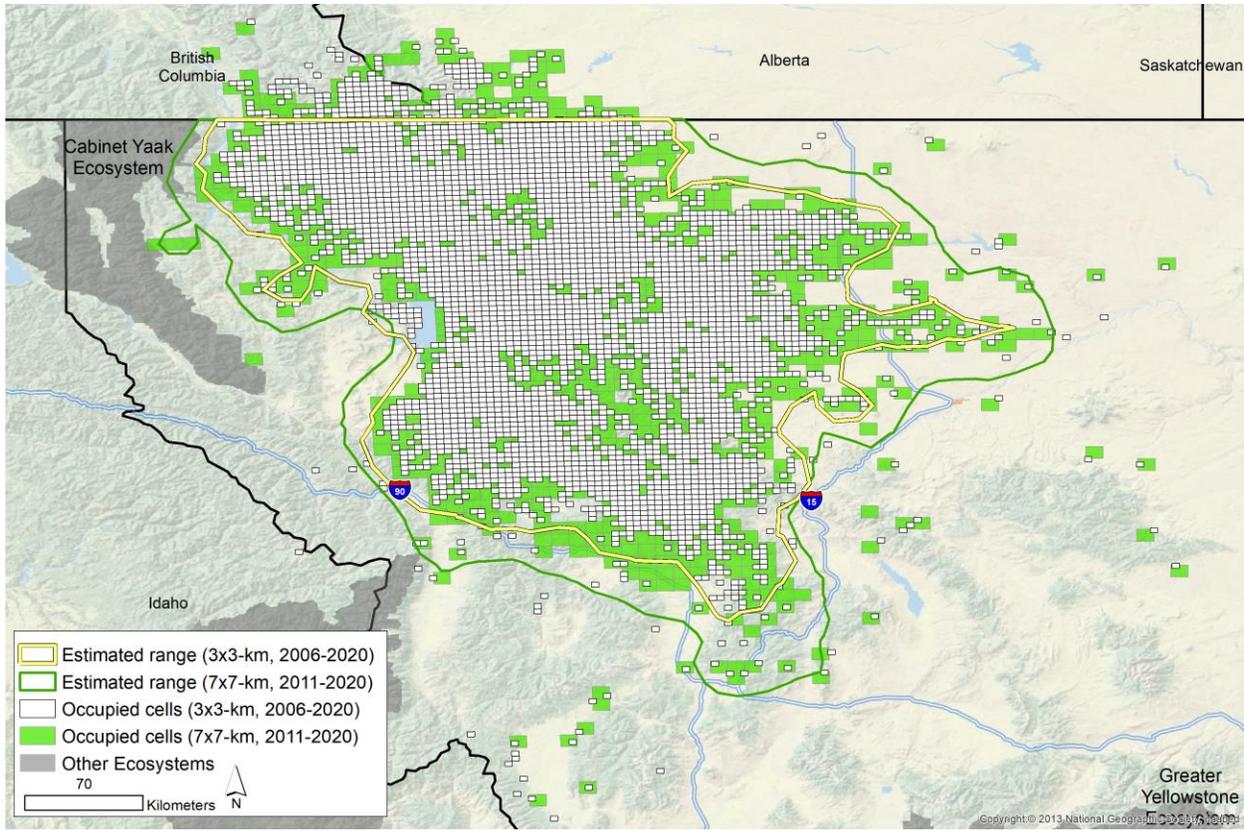


Figure 6. Comparison of occupied cells and resulting estimated occupied range of the NCDE grizzly bear population using two different sets of parameters with zonal analysis and ordinary kriging of verified grizzly bear locations. The original analysis involved data from 2011–2020, 7x7-km grid cells, and all GPS data. The revised analysis involved data from 2006–2020, 3x3-km grid cells, and GPS data screened to only one random location per bear per day.

We completed genetic analysis of NCDE samples collected through 2021 (genotypes from 2022 NCDE samples are not yet available). We examined genotype, capture, and monitoring data in the NCDE and other ecosystems to document movements among ecosystems. Analysis of NCDE samples from 2021 and radio-monitoring of NCDE bears in 2022 revealed no immigration from the NCDE to the CYE. Movement of one bear from the CYE to the NCDE was documented from genetic pedigree analyses (Justin Tiesberg, USFWS, personal communication). Female bear 842014086 was captured for conflict near Whitefish in Aug 2021 at age 2 and was relocated to the Middle Fork of the Flathead River where she shed her collar. Pedigree analysis indicated that CYE female 925063, detected as a cub in the Cabinet Mountains in 2012, was her probable mother. Male 770 was her probable father. This male was radio-monitored in the Cabinet Mountains during 2005–2006 and 2019 and then removed for conflict in 2019.

Distance between the initial capture site of female 842014086 in Whitefish and the approximate range centers of her parents in the Cabinet Mountains was about 90 km, a relatively long distance for female dispersal (Fig. 7). By 2022, however, this female had returned to the Cabinet Mountains and was recaptured twice more for conflict and was removed.

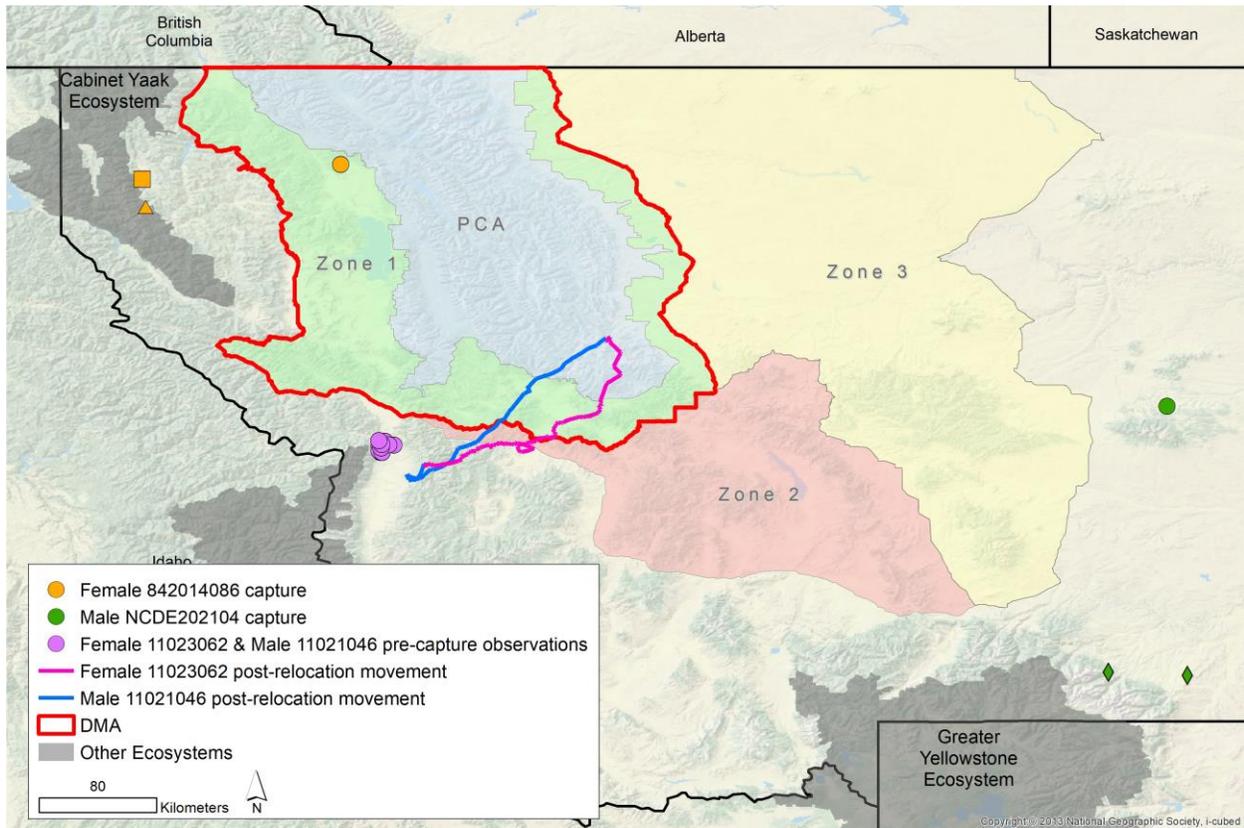


Figure 7. Locations (circles) or post-relocation movements (lines) of grizzly bears observed outside of their known or presumed ecosystem of birth during 2021 or 2022, relative to color-coded approximate range centers for a probable mother (triangle), father (square) or close relatives (diamonds) as estimated from genetic analyses. Zones as described in Fig. 1.

Principal components analysis was conducted on 16-loci genotypes obtained from bears captured in the NCDE and the GYE through 2021. For all bears captured within or near the DMAs, the discreteness of the clusters indicated that no individuals originated from the population other than where they were captured. Thus, to date, we have not detected evidence of immigration into the NCDE from the GYE or emigration from the NCDE into the GYE. Male bear NCDE202104, who was captured and removed for cattle depredation north of the Snowy Mountains in 2021, 210 km east of the NCDE DMA, clustered with the GYE population. Subsequent parentage analyses failed to identify a mother or father for this individual but identified two close relatives, female 957 and male GYE202016, that had been captured outside of

the GYE DMA in the northeast part of the ecosystem during 2018–2020. Distance between the bear and its close relatives was approximately 185 km (Fig. 7).

Although genetic analyses are not yet complete to verify their population of origin, the movements of two presumed siblings in 2022 suggest dispersal from the NCDE to the Bitterroot Valley. Female 11023062 and male 11021046 were observed or captured by remote cameras several times in the Sapphire and Bitterroot Mountains during Aug and Sep 2022. Although the pair was not believed to have accessed unnatural foods, they were frequenting residential areas where unsecured garbage and attractants were abundant. In Oct 2022, they were preemptively captured, collared, and relocated to the Welcome Creek Wilderness area in the Sapphire Mountains. They were captured on different days and released separately, but both made directional movements toward the NCDE almost immediately. Within 12 days of release, they reunited about 122 km from their release sites and entered a nearby den together within another 17 days. These behaviors suggest familiarity with this area of the Scapegoat Wilderness and a possible natal range. Distance from the den site to their farthest pre-capture location was about 130 km (Fig. 7).

SUMMARY OF HUMAN-GRIZZLY BEAR CONFLICT PREVENTION AND RESPONSE

Methods

Our monitoring team agencies employ specialists involved in human-grizzly bear conflict prevention and response. During 2020, we developed an ecosystem-wide management database for recording agency responses to grizzly bears or human-grizzly bear conflict and preventative measures taken, as described in the Conservation Strategy (NCDE Subcommittee 2019).

Results

We continued use of the ecosystem-wide management database during 2022, where we recorded grizzly bear conflicts, preventative actions taken, opportunistic samples collected, and bear observations. Reported data for the Blackfeet Reservation only included incidents where a bear was captured or removed.

Agency management specialists responded to >285 incidents of human-grizzly bear conflict (Table 6). They also responded to 122 other reports or complaints, where bears were near people or property, but not involved in conflict behavior (Table 7). About 39% of human-bear conflicts involved bears accessing unnatural foods, especially garbage or feed. Another 20% involved bears damaging property, primarily while attempting to access unnatural foods or residential chicken coops. About 29% involved

grizzly bear depredation, mostly of chickens or cattle. Conflicts related to grizzly bear interactions with humans or agriculture accounted for 12% of conflicts.

Table 6. Summary of human-grizzly bear conflicts in the NCDE, 2022. Conflict incidents involved an interaction between a grizzly bear and human in which bears either did, or attempted to, damage property, kill or injure livestock, damage beehives, injure people, or obtain anthropogenic foods or attractants or agricultural crops.

Category	Detail	BIR ¹	FIR	FWP R1	FWP R2	FWP R4	GNP	Outside	Total
Unnatural Foods	Garbage/waste site		1	47	14	1	1		64
	Pet/livestock feed	4		26	4	2			36
	Human foods	1		4					5
	Bird feeder			1	2				3
	Other			3					3
	Subtotal	5	1	81	20	3	1		111
Depredation	Chickens/poultry		3	25	1	5			34
	Cattle	10			4	19			33
	Sheep				3	5			8
	Other		1	3		2		1	7
	Subtotal	10	4	28	8	31		1	82
Property damage	Building			27	11	5			43
	Enclosure			7	3				10
	Other		1	2	1				4
	Subtotal		1	36	15	5			57
Human interaction	Aggressive encounter		1	2	4	3			10
	Habituation			7	1				8
	DOL shooting		1	1		1			3
	Entry of dwelling			1		1			2
	Subtotal		2	11	5	5			23
Agricultural damage	Orchard/fruit tree			4					4
	Stored grain		2	1	1				4
	Beehives			1		2			3
	Crop		1						1
	Subtotal		3	6	1	2			12
Total		15	11	162	49	46	1	1	285

¹ Only data associated with captures or mortalities were reported.

Table 7. Summary of reports or complaints where grizzly bears were near people or property but not involved in conflict behavior in the NCDE, 2022.

Category	Detail	FIR	FWP			Outside	Total
			R1	R2	R4		
Bear near people	Naturally	2	45	1	8		56
	Known or possible attractants	1	15	14	10	1	41
Bear near property	Livestock	2	3	2	2		9
	Spilled grain				8		8
	Boneyard or carcass	2		1	1		4
	Other		2	1	1		4
Total		7	64	19	30	1	122

¹ Data are incomplete at present; only data associated with captures are included.

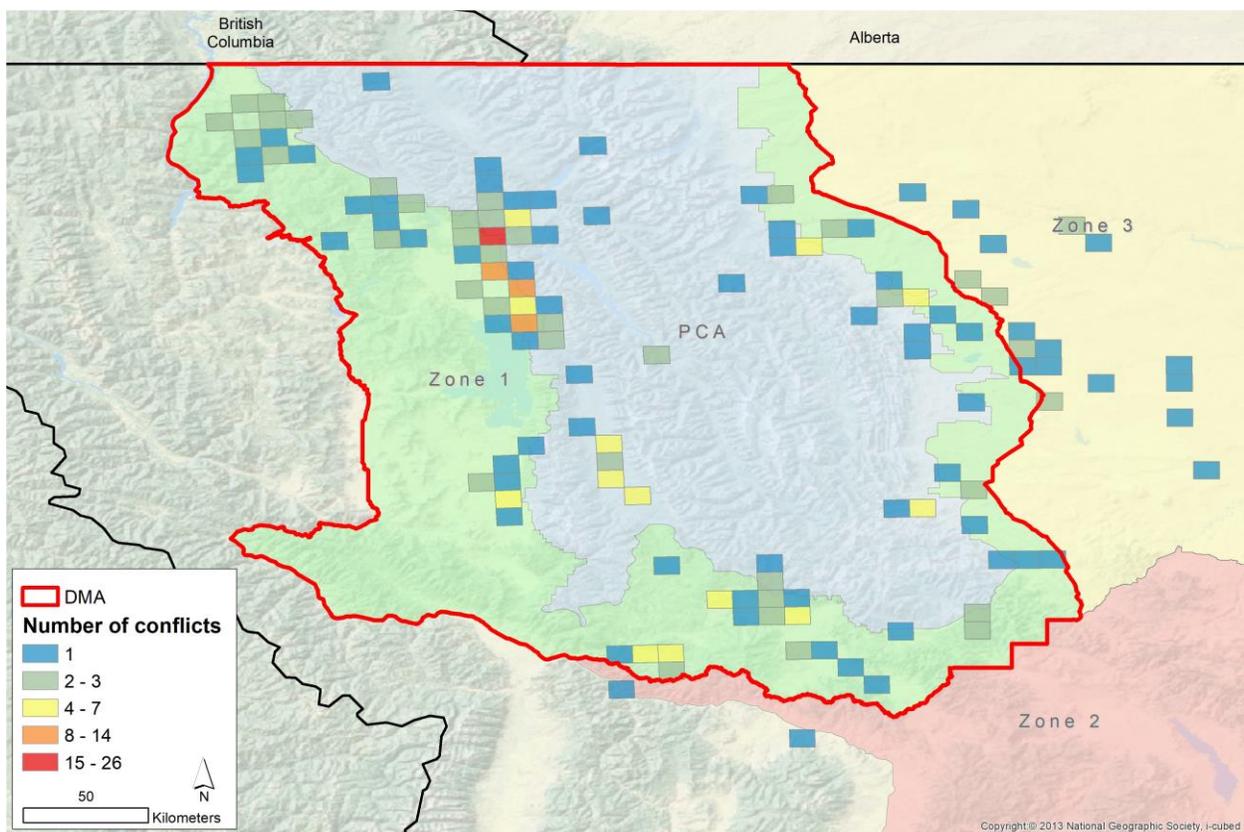


Figure 8. General distribution of reported human-grizzly bear conflicts in the NCDE and surroundings, 2022. Colors correspond to counts of conflicts recorded within 7 km x 7km grid cells. Zones as described in Fig. 1.

Numbers of conflict incidents were, by far, highest within FWP Region 1 (Table 6, Fig. 7). Numbers of conflicts were low in Glacier National Park and relatively low on the Flathead Reservation. The majority of conflicts occurred in Zone 1 (61%), especially on the west side of the Continental Divide. Thirty-one percent of conflicts occurred in the PCA, primarily near the periphery. Eight percent of conflicts occurred in Zone 3 and <1% occurred in Zone 2 or outside of the Conservation Strategy Zones.

In responding to conflicts, agency management specialists provided education and outreach and took hundreds of actions to prevent conflict, including: securing attractants (sometimes with electric fence); removing attractants (including carcass removal); monitoring (usually with remote cameras); hazing or use of scare devices; posting of warnings or temporary closures; and issuing warnings for violations related to food storage or feeding wildlife. Management specialists took 71 actions involving captured bears including: preemptively capturing 8 bears to prevent conflict; releasing or translocating 9 non-target bears captured at conflict sites but likely not involved in conflict; translocating 24 bears involved in conflicts; and removing 30 bears involved in conflict (Table 8).

Table 8. Summary of non-capture management actions taken to reduce human-grizzly bear conflict, NCDE and surroundings, 2022.

Event	Category	Secured or removed attractants	Monitored cameras	Hazed or scare device	Posted warning or closure	Issued warning or citation	Total
Report or complaint	Bear near people	34	75	19	7		135
	Bear near property	17	7	10	3		37
Conflict	Unnatural foods	99	52	18	1	2	172
	Depredation	54	30	13	1		98
	Property damage	42	35	23		1	101
	Human interaction	5	9	6	6		26
	Agricultural damage	10	2	1			13
Total		261	210	90	21	3	582

Table 9. Summary of management-related captures of grizzly bears, NCDE and surroundings, 2022. Numbers in parentheses refer to dependent offspring with their mothers.

Event	Category	Preemptive capture	Nontarget capture	Target released onsite	Target translocated	Target removed	Total
Report or complaint	Bear near people	1					1
	Bear near property	4				3 ¹	7
Conflict	Unnatural foods		4	2	9 (2)	2 (2)	17 (4)
	Depredation	1 (2)	5		8	12 (2)	26 (2)
	Property damage				2 (3)	3 (1)	5 (4)
	Human interaction					5	5
Total		6 (2)	7	2	19 (5)	25 (5)	59 (12)

¹ Bears removed due to illness, tested positive for HPAI

SUMMARY OF OTHER RESEARCH AND MONITORING

During 2022, members of the NCDE trend monitoring program were also involved in other research projects involving grizzly bear in the NCDE, Montana, and elsewhere.

Collaborating with Dr. Sarah Sells (University of Montana), we used NCDE GPS data to develop models for predicting habitat selection and connectivity corridors among Recovery Zones and published three papers since our last report. Sells et al. (2022) developed models for predicting grizzly bear habitat selection in the NCDE. Sells et al. (2023a) tested applicability of these habitat selection models to the nearby CYE, SE, and GYE areas. Sells et al. (2023b) used the NCDE habitat selection models to predict connectivity corridors linking the NCDE, CYE, GYE, and BE. We are currently working on additional analyses to apply the NCDE models to the BE and NCE; and to incorporate home range characteristics into our modeling to predict future expansion of occupied range.

With collaborators Dr. Holly Nesbitt, Dr. Alex Metcalf, and Dr. Elizabeth Metcalf (University of Montana) we published a paper based on our statewide survey of Montanan's views on grizzly bears and their management. Nesbitt et al. (2023) revealed some of the social factors underlying Montanans' satisfaction with grizzly bear management and coexistence beliefs.

With Dr. Andrea Corradini and Dr. Francesca Cagnacci from the University of Trento and members of the GYE Interagency Grizzly Bear Study Team, we coauthored a paper revealing evidence of density-dependent effects on body composition of grizzly bears in the GYE (Corradini et al. 2023).

We continued our collaborative with Dr. Julie Young (Utah State University) to investigate if guard dogs are an effective deterrent for farmsteads with abundant grain spills. Field work was completed in 2022 and analyses are currently underway.

With collaborators from the CYE, the GYE, and Gates of the Arctic National Park and Preserve (AK), we continued analyses of female grizzly bear activity data obtained from GPS collars to test if parturition events are detectable during the denning season. This work was presented at the annual meeting of the Montana Chapter of the Wildlife Society in Feb 2022 and manuscripts are being completed.

Along with members of the Interagency Grizzly Bear Study Team, we continued our collaboration with Dr. Paul Lukacs and Dr. Josh Nowak (University of Montana) to develop an integrated population model for the GYE and NCDE populations. A working model has been developed for the GYE population, but refinements are continuing. As the NCDE does not have annual count data (such as the counts of females with cubs in the GYE), we continued testing inputs for the NCDE model.

We continued monitoring GPS-collared grizzly bears in FWP Region 4 to investigate grizzly bear use of grain bins. Field work will be completed in 2023.

We continued our collaboration with Dr. Michael Proctor (Birchdale Ecological) to analyze responses and outcomes associated with residential human-grizzly bear conflicts in the NCDE and nearby populations in British Columbia.

Collaborating with Mark Haroldson (USGS IGBST) and Jennifer Fortin-Noreus (USFWS), we continued collecting, verifying, and compiling records of outlier grizzly bear observations.

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APPENDICES

Appendix A. Fates of radio-monitored grizzly bears captured for trend monitoring within the DMA or other purposes inside and outside of the DMA, NCDE, 2022.

Purpose	Sex	Bear ID	DMA	Independent	Age	Fate
Trend	Female	601604325	Yes	Yes	2	Alive
Trend	Female	605569626	Yes	Yes	4	Alive
Trend	Female	605574067	Yes	Yes	4	Alive
Trend	Female	605575821	Yes	Yes	4	Alive
Trend	Female	606845087	Yes	Yes	4	Alive
Trend	Female	839842014	Yes	Yes	4	Alive
Trend	Female	605559120	Yes	Yes	6	Censored
Trend	Female	841893020	Yes	Yes	6	Alive
Trend	Female	601608034	Yes	Yes	7	Alive
Trend	Female	839839014	Yes	Yes	7	Censored
Trend	Female	601582810	Yes	Yes	8	Alive
Trend	Female	841778369	Yes	Yes	8	Alive
Trend	Female	605567617	Yes	Yes	9	Alive
Trend	Female	605570788	Yes	Yes	11	Alive
Trend	Female	606844805	Yes	Yes	11	Alive
Trend	Female	842014813	Yes	Yes	11	Alive
Trend	Female	605564553	Yes	Yes	12	Alive
Trend	Female	601610593	Yes	Yes	13	Alive
Trend	Female	11018035	Yes	Yes	14	Alive
Trend	Female	11052544	Yes	Yes	14	Censored
Trend	Female	39036349	Yes	Yes	14	Alive
Trend	Female	41519364	Yes	Yes	14	Alive
Trend	Female	41580379	Yes	Yes	14	Alive
Trend	Female	79597603	Yes	Yes	15	Alive
Trend	Female	842018043	Yes	Yes	15	Censored
Trend	Female	79570382	Yes	Yes	17	Censored
Trend	Female	97616524	Yes	Yes	21	Alive
Trend	Male	41512554	Yes	Yes	9	Censored
Trend	Male	841895894	Yes	Yes	2	Censored
Trend	Male	842001886	Yes	Yes	4	Alive
Trend	Male	601617019	Yes	Yes	7	Alive
Trend	Male	605568103	Yes	Yes	8	Censored
Trend	Male	605575053	Yes	Yes	8	Alive
Trend	Male	842019074	Yes	Yes	8	Censored
Trend	Male	39875815	Yes	Yes	12	Censored
Other	Female	605564317	Yes	No	0	Alive
Other	Female	605573051	Yes	No	0	Alive
Other	Female	10879850	Yes	Yes	2	Dead

Purpose	Sex	Bear ID	DMA	Independent	Age	Fate
Other	Female	11023062	No	Yes	2	Alive
Other	Female	604516820	Yes	Yes	2	Censored
Other	Female	605566022	Yes	Yes	3	Alive
Other	Female	842006863	Yes	Yes	3	Censored
Other	Female	842027068	No	Yes	3	Dead
Other	Female	842029879	No	Yes	3	Alive
Other	Female	601596579	Yes	Yes	4	Censored
Other	Female	605573370	No	Yes	4	Alive
Other	Female	605575337	Yes	Yes	4	Censored
Other	Female	842029091	Yes	Yes	4	Alive
Other	Female	605559048	Yes	Yes	5	Alive
Other	Female	605579282	No	Yes	5	Censored
Other	Female	842032271	Yes	Yes	5	Censored
Other	Female	604381104	Yes	Yes	6	Dead
Other	Female	604521558	Yes	Yes	7	Alive
Other	Female	604521783	Yes	Yes	7	Censored
Other	Female	604524782	Yes	Yes	7	Unknown
Other	Female	605561793	Yes	Yes	7	Alive
Other	Female	605569812	Yes	Yes	7	Alive
Other	Female	605571600	Yes	Yes	7	Alive
Other	Female	36554859	Yes	Yes	8	Alive
Other	Female	605562550	Yes	Yes	9	Censored
Other	Female	842015615	Yes	Yes	9	Alive
Other	Female	605563809	Yes	Yes	13	Censored
Other	Female	79560108	Yes	Yes	14	Censored
Other	Female	97605011	Yes	Yes	15	Censored
Other	Female	605561265	Yes	Yes	15	Alive
Other	Female	95636784	Yes	Yes	16	Alive
Other	Female	605576598	Yes	Yes	17	Alive
Other	Female	601602122	Yes	Yes	19	Censored
Other	Female	604514826	Yes	Yes	36	Censored
Other	Male	601613822	Yes	No	1	Dead
Other	Male	11021046	No	Yes	2	Alive
Other	Male	604525600	Yes	Yes	2	Alive
Other	Male	842002302	No	Yes	2	Dead
Other	Male	842019271	Yes	Yes	2	Dead
Other	Male	601582786	No	Yes	3	Alive
Other	Male	999	No	Yes	4	Alive
Other	Male	601614092	Yes	Yes	4	Dead
Other	Male	604515023	Yes	Yes	4	Alive
Other	Male	841810847	Yes	Yes	4	Dead
Other	Male	842012037	Yes	Yes	5	Dead

Purpose	Sex	Bear ID	DMA	Independent	Age	Fate
Other	Male	606846815	Yes	Yes	7	Alive
Other	Male	10870331	Yes	Yes	10	Censored
Other	Male	842002319	Yes	Yes	12	Censored
Other	Male	41636273	Yes	Yes	14	Alive
Other	Male	604520568	Yes	Yes	15	Alive

Appendix B. Observed reproductive status and offspring mortality for adult (≥ 4 years old) female grizzly bears radio-monitored in the NCDE, 2022.

Sample	Collared	Bear ID	Age	Status	Litter size	Offspring mortality	Multiple observations	Date first observed	Status previous year (if known)	Litter size previous year (if known)
Other	Yes	601596579	4	None				4/26/2022		
Other	Yes	605573370	4	None				7/29/2022		
Trend	Yes	605574067	4	None				7/14/2022		
Other	Yes	605575337	4	None				6/22/2022		
Trend	Yes	605575821	4	None				9/18/2022		
Trend	Yes	606845087	4	None				9/29/2022		
Trend	Yes	839842014	4	None				5/2/2022		
Trend	No	842020329	4	Cub	2		No	7/11/2022		
Other	Yes	842029091	4	None				4/26/2022		
Trend	No	41628288	5	Cub	3		No	5/2/2022		
Other	Yes	605559048	5	None				9/9/2022		
Other	Yes	605579282	5	Cub	2		No	6/24/2022		
Other	Yes	604381104	6	Cub	2	1	Yes	9/29/2022	Yearling	2
Trend	Yes	605559120	6	None				7/30/2022		
Trend	Yes	841893020	6	Cub	1		No	8/4/2022		
Other	No	842006256	6	Cub	2		No	8/29/2022		
Trend	Yes	601608034	7	Cub	3	3	Yes	5/14/2022	None	
Other	Yes	604521558	7	None				5/7/2022	None	
Other	Yes	604521783	7	2-year-old	2		No	4/7/2022	Yearling	2
Other	Yes	605561793	7	None				8/18/2022		
Other	Yes	605569812	7	None				10/7/2022		
Other	Yes	605571600	7	Cub	2		No	8/7/2022		
Trend	Yes	839839014	7	None				6/28/2022		
Other	Yes	36554859	8	Cub	1		No	9/3/2022		
Trend	Yes	601582810	8	None				7/9/2022		
Trend	Yes	841778369	8	None				6/27/2022	None	
Trend	Yes	605567617	9	None				6/27/2022		
Other	Yes	842015615	9	Yearling	2	0	Yes	5/14/2022	Cub	2

Sample	Collared	Bear ID	Age	Status	Litter size	Offspring mortality	Multiple observations	Date first observed	Status previous year (if known)	Litter size previous year (if known)
Other	No	NCDE202234	9	Cub	1		No	9/16/2022		
Other	No	41623606	11	Cub	1		No	9/27/2022		
Trend	Yes	605570788	11	None				9/20/2022		
Trend	Yes	606844805	11	None				9/29/2022		
Trend	Yes	842014813	11	Yearling	1		No	6/27/2022	Cub	1
Trend	Yes	605564553	12	None				6/6/2022		
Trend	Yes	601610593	13	None				6/27/2022	2-year-old	2
Trend	Yes	11018035	14	Cub	2	0	Yes	6/22/2022	2-year-old	2
Trend	Yes	39036349	14	Cub	3	0	Yes	5/20/2022	Yearling	2
Trend	Yes	41519364	14	2-year-old	2		No	4/28/2022		
Trend	Yes	41580379	14	Cub	2		No	6/28/2022	None	
Trend	Yes	79597603	15	2-year-old	1	0	Yes	4/25/2022	Yearling	2
Other	Yes	97605011	15	Yearling	2	2	Yes	4/8/2022		
Other	Yes	605561265	15	Cub	3		No	8/4/2022		
Trend	Yes	842018043	15	None				6/22/2022	None	
Other	Yes	95636784	16	Yearling	3		No	6/22/2022	Cub	3
Other	Yes	605576598	17	None				8/21/2022		
Other	Yes	604514826	36	None				6/28/2022	None	

Appendix C. Known and probable grizzly bear mortalities in the NCDE, 2022.

Date	Date accuracy	Certainty of death	Sex ¹	Age Class ²	Age	Collared	Bear ID	Zone	Cause of death
4/1/2022	Day	Known	M	AD	5	Yes	842002302	PCA	Undetermined-Under investigation
4/18/2022	Day	Known	M	AD	4	No		Zone 1	Agency removal-Livestock depredation
4/30/2022	Day	Known	M	AD	5	No		PCA	Agency removal-Livestock depredation
5/4/2022	Day	Known	M	AD	5	No		Zone 1	Accidental-Train
5/5/2022	Week	Known	M	YR	1	No		Zone 3	Natural-Natural
5/10/2022	day	Known	M	AD	13	No	36311260	Zone 1	Agency removal-Livestock depredation
5/13/2022	Day	Known	F	AD	5	No		Zone 1	Accidental-Automobile
5/18/2022	Day	Known	F	SA	3	Yes	842027068	Canada	Public-Hunting
5/18/2022	Day	Known	M	SA	3	No	41580345	Canada	Public-Hunting
5/18/2022	Day	Known	F	AD	5	No		PCA	Agency removal-Livestock depredation
5/20/2022	Day	Probable	U	UNK	3	No		PCA	Public-DOL
5/27/2022	Day	Known	M	AD	22	No		PCA	Agency removal-Food/property/habituation
5/30/2022	Day	Known	F	SA	2	No		Zone 1	Agency removal-Bear injury/disease
6/24/2022	Day	Known	F	SA	3	Yes	842014086	Outside	Agency removal-Food/property/habituation
6/28/2022	Day	Known	M	YR	1	Yes	601613822	Zone 1	Agency removal-Food/property/habituation
6/28/2022	Day	Known	M	SA	3	No		Zone 3	Agency removal-Livestock depredation
7/11/2022	Day	Known	M	SA	3	Yes	841810847	PCA	Agency removal-Food/property/habituation
7/11/2022	Day	Known	M	SA	2	Yes	842019271	PCA	Agency removal-Food/property/habituation
7/11/2022	Day	Known	F	AD	4	No	842020329	Zone 1	Agency removal-Food/property/habituation
7/12/2022	Day	Known	M	CB	0	No		Zone 1	Agency removal-Food/property/habituation
7/12/2022	Day	Known	M	CB	0	No		Zone 1	Agency removal-Food/property/habituation
7/13/2022	Day	Known	F	SA	2	Yes	10879850	Zone 1	Accidental-Poisoning
7/20/2022	Day	Known	M	CB	0	No		Zone 1	Accidental-Automobile
8/1/2022	Year-summer	Known	U	CB	0	No		Zone 3	Natural-Natural
8/22/2022	Day	Known	F	SA	2	No		Zone 1	Agency removal-Bear injury/disease
8/24/2022	Day	Known	M	SA	3	No		Zone 1	Agency removal-Livestock depredation
8/25/2022	Day	Known	M	AD	10	No		Zone 1	Accidental-Automobile
8/27/2022	Day	Known	F	AD	5	No		Zone 1	Accidental-Train

Date	Date accuracy	Certainty of death	Sex ¹	Age Class ²	Age	Collared	Bear ID	Zone	Cause of death
8/27/2022	Day	Known	M	YR	1	No		Zone 1	Accidental-Train
8/27/2022	Day	Known	M	AD	10	No		PCA	Agency removal-Livestock depredation
8/31/2022	Day	Known	M	AD	5	Yes	842012037	PCA	Public-Illegal DOP
9/3/2022	Day	Known	F	AD	15	No		PCA	Agency removal-Livestock depredation
9/4/2022	Day	Known	M	SA	3	No		Zone 3	Accidental-Automobile
9/6/2022	Day	Known	M	SA	2	No		Zone 3	Accidental-Automobile
9/9/2022	Day	Known	M	AD	4	Yes	601614092	Zone 1	Agency removal-Livestock depredation
9/16/2022	Day	Known	F	AD	5	No		Zone 1	Agency removal-Food/property/habituation
9/16/2022	Day	Known	M	CB	0	No		Zone 1	Agency removal-Food/property/habituation
9/21/2022	Day	Known	F	AD	4	No	604379286	Zone 3	Agency removal-Human aggression/injury/fatality
9/22/2022	Day	Known	F	AD	17	No	11060268	PCA	Accidental-Automobile
9/23/2022	Day	Known	F	CB	0	No		Zone 3	Agency removal-Bear injury/disease
9/23/2022	Day	Known	M	AD	13	No	36561046	Zone 1	Agency removal-Livestock depredation
9/25/2022	Day	Known	F	CB	0	No		Zone 1	Agency removal-Bear injury/disease
9/27/2022	Day	Known	F	AD	11	No	41623606	Zone 1	Agency removal-Livestock depredation
9/29/2022	Day	Known	F	CB	0	No		PCA	Accidental-Automobile
10/8/2022	2 weeks	Known	F	AD	25	No		Zone 3	Undetermined-Unknown
10/11/2022	Day	Known	M	AD	14	No		Zone 3	Agency removal-Human aggression/injury/fatality
10/24/2022	Day	Known	M	SA	3	No		PCA	Accidental-Automobile
10/29/2022	Day	Known	M	YR	1	No		PCA	Agency removal-Bear injury/disease
10/31/2022	Day	Known	F	AD	6	Yes	604381104	PCA	Agency removal-Livestock depredation
10/31/2022	Day	Probable	F	CB	0	No	606840081	PCA	Agency removal (orphaned)-Livestock depredation
11/14/2022	Day	Known	M	SA	3	No		PCA	Accidental-Automobile

¹ F = female, M = male, U = unknown sex

² AD = adult, SA = subadult, YR = yearling, CB = cub

³ These two individuals were previously captured in the NCDE in 2021 along with their mother. The mother and the female offspring were radio-monitored. These offspring deaths occurred in Alberta, Canada. Mortalities of both the collared and non-collared individual were recorded because of their NCDE history.

⁴ This individual was previously captured and radio-monitored in the NCDE during 2021. The bear shed here collar in 2021. In 2022, she was recaptured and recollared, then recaptured and removed in the CYE. The mortality of this bear was recorded because of her NCDE history.

Appendix D. Observed occupancy of 23 Bear Management Units within the PCA and 7 Occupancy Units within Zone 1 by female grizzly bears with offspring, 2017–2022. Units known occupied during a given year are signified by the symbol x. Twenty-two of 23 BMUs and 7 of 7 OUs were occupied during a 6-year period ending with 2022.

Bear Management Unit (PCA)	2017	2018	2019	2020	2021	2022
Murphy Lake	x			x		x
Upper North Fork Flathead	x		x	x	x	x
Northeast Glacier	x	x	x	x	x	x
Stillwater River		x	x	x	x	x
Lower North Fork Flathead	x	x	x	x	x	x
Hungry Horse	x	x	x	x	x	
Lower Middle Fork Flathead	x	x	x	x	x	x
Southeast Glacier	x	x	x	x	x	x
Sullivan	x	x	x	x	x	x
Upper Middle Fork Flathead	x	x				x
Badger Two Medicine	x	x	x	x		x
Mission Range	x	x	x	x	x	x
Bunker	x	x	x	x	x	
Continental Divide				x		x
Birch Teton	x	x	x	x	x ¹	
Big Salmon		x	x	x	x	x
North Fork Sun River	x	x	x	x		x
Teton Sun River	x		x	x	x	x
Rattlesnake					x	
Upper South Fork Flathead	x				x	
South Fork Sun Beaver Willow	x	x	x	x	x	x
Monture Landers Fork	x		x	x	x	x
Dearborn Elk Creek	x		x	x	x	
Occupied during year	19	15	18	20	18	17
Occupied during last 6 years	23	22	22	23	23	23
Occupancy Unit (Zone 1)						
Salish Connectivity Area	x	x	x	x	x	x
Flathead Valley	x	x	x	x	x	x
Flathead Reservation	x	x	x	x	x	x
Ninemile Connectivity Area		x	x	x		
South End	x	x	x	x	x	x
East Front	x	x	x	x	x	x
Blackfeet Reservation	x	x	x	x	x	x
Occupied during year	6	7	7	7	6	6
Occupied during last 6 years	7	7	7	7	7	7

¹ Observation from 2021 recorded from remote camera downloaded in 2022.

Appendix E. Thresholds and observed estimates for demographic objectives described in the 2019 Conservation Strategy, 2017–2022. Parameters include occupancy of females with offspring within 23 Bear Management Units (BMUs) in the Primary Conservation Area (PCA) and 7 Occupancy Units (OUs) in Zone 1, tallied over the last 6 years; survival rate of independent females within the Demographic Monitoring Area (DMA) averaged over the last 6 years; and numbers of total reported and unreported (TRU) mortalities of independent female and male grizzly bears within the DMA averaged over the last 6 years.

Parameter	Area or Sex	Threshold/ observed	Year					
			2017	2018	2019	2020	2021	2022
Occupancy	PCA (BMUs)	Minimum	21	21	21	21	21	21
		Observed	23	22	22	23	23	23
	Zone 1 (OUs)	Minimum	6	6	6	6	6	6
		Observed	7	7	7	7	7	7
Survival rate	Female	Minimum	0.93	0.93	0.93	0.93	0.93	0.92
		Observed	0.95	0.93	0.94	0.93	0.93	0.93
TRU mortalities	Female	Maximum	22	22	23	24	25	25
		Observed	14	15	16	13	15	15
	Male	Maximum	28	28	29	29	30	30
		Observed	19	21	21	21	23	25

Objectives: Provide guidance to estimate **occupied range for each grizzly bear population**. **Occupied range** is an estimate of the roughly contiguous area within which bears have established residency or have demonstrated habitat use. *Estimated occupied range represents a minimum known area of occupancy. It does not include occasional forays outside the estimated range or low-density peripheral areas and therefore does not represent the total known extent of occurrences (See May Be Present). Due to the smoothing inherent in the methodology, range edges may extend over features that might act as partial barriers to grizzly bear movement, such as I-90 or Lake Kookanusa. Range estimates for neighboring populations may also overlap, but this does not represent evidence of genetic and/or demographic connectivity. Males generally disperse farther than females, and often account for the leading edge of range expansion. As grizzly bears expand into historical range, it is possible to have occupied range without female presence; however, female reproduction is necessary to establish a population.*

Background: Bjornlie *et al.* (2014) developed a technique using all verified grizzly bear location data, zonal analysis, and kriging to estimate occupied range for the Greater Yellowstone Ecosystem. This document provides clarification and guidance for applying the technique developed by Bjornlie *et al.* (2014) to each grizzly bear population in the lower-48 States.

Methods:

Data:

Location data will include the following sources: known locations of captures, mortalities, human-grizzly bear conflicts, and field collection of hair samples attributed to grizzly bears through DNA analysis; VHF and GPS locations from radio-monitored bears; and locations of sightings or tracks reported or verified by experienced agency personnel.

Data from GPS collared bears will be screened. Unlike other data sources that rarely include more than one location per individual per day, GPS data sets may include as many as 48 locations per individual per day. To account for this sizable difference in data frequency, GPS data for each individual will be screened to exclude all but 1 randomly selected location per day. This will ensure that GPS data are not overrepresented in the data set and are appropriately scaled to the daily activity radius used to determine the grid size (*see Grid Size below*).

Data from bears that were relocated as a response to human-bear conflict or translocated for population and/or genetic augmentation, will be screened. After relocation and/or translocation, bears often wander widely, while trying to return to their original area or while searching for a suitable place to settle. To reduce the effect of these human-influenced movements on occupied range estimates, post-relocation/translocation locations will be excluded if they are outside of previous estimates of occupied range and they are either: (1) outside of either the bear's known home range or a circular area around the capture site with a radius equal to the mean home range radius (NCDE: 12 km for females, 21 km for males), indicating they have not successfully returned to their place of origin; or (2) they are wide-ranging and non-concentrated (i.e., do not resemble a newly-established home range).

The 1-per-day screening of GPS locations should help reduce the influence of any occasional long-range, single-track excursions made by collared bears (not associated with translocation). If not, however, movements such as these might be excluded if they are assumed to be associated with a temporary movement by a single individual and if they unduly distort the extent of occupied range. Other considerations may include known age and population of origin, as subadult individual movements tend to include exploratory excursions.

Timeframe: Grizzly bears are a long-lived species and due to small sample size, annual data from observations and radio-collaring efforts cannot accurately represent the extent of occurrence. Because of this, the NCDE and GYE will use a 15-year moving window. The CYE and SE will use a 20-year moving window due to the smaller population size and resulting smaller available data set.

Grid size: A 3km x 3km grid will be laid across the lower-48 States using ArcGIS. The grid-cell size was selected based on the mean daily activity radius for male grizzly bears (1.44 km for the GYE, 1.29 km for the NCDE, and 1.21 km for the CYE and SE). For further details see Bjornlie *et al.* 2014.

Kriged surface: One contiguous, occupied range will be mapped for each grizzly bear population. Small disjunct "islands", separate from the larger population range, will be excluded.

Appendix G. Maps of revised biennial estimates of occupied range of the NCDE grizzly bear population (green shading), as estimated by applying zonal analysis and ordinary kriging with 3x3-km cells with verified grizzly bear locations during a 15-year time window, 2004–2022.

